Why 'Basel II' May Need a Leverage Ratio Restriction*

Jürg M. Blum
Swiss National Bank
Börsenstrasse 15
8022 Zürich
Switzerland

April 10, 2007

Abstract

We analyze regulatory capital requirements where the amount of required capital depends on the level of risk reported by the banks. It is shown that if the supervisors have a limited ability to identify or to sanction dishonest banks, an additional, risk-independent leverage ratio restriction may be necessary to induce truthful risk reporting. The leverage ratio helps to offset the banks' potential capital savings of understating their risks by (i) reducing banks' put option value of limited liability *ex ante*, and by (ii) increasing the banks' net worth, which in turn enhances the supervisors' ability to sanction banks *ex post*.

Keywords: Banks, capital requirements, leverage ratio restriction, Basel II.

JEL Classification Numbers: G21, G28

*Without implicating them, I would like to thank Martin Brown, Hendrik Hakenes, Martin Hellwig, George Kaufman and Isabel Schnabel for very helpful comments and suggestions. I am particularly indebted to Robert Bichsel for many stimulating discussions on this topic. I also gratefully acknowledge comments from seminar participants at the Swiss National Bank and at the Max Planck Institute for Research on Collective Goods. The views expressed in this paper are mine and do not represent those of the Swiss National Bank. Email: juerg.blum@snb.ch

1 Introduction

The new international capital framework for banks, also known as 'Basel II', seeks to align regulatory capital requirements more closely to the underlying risks that banks face. This improved risk sensitivity is intended to be achieved through a greater use of assessments of risk provided by banks' internal systems as inputs to capital calculations.[1] Despite these innovations, in the US the Federal Deposit Insurance Corporation (FDIC) insists on maintaining an additional risk-independent capital requirement that is proportional to the size of banks' assets, a so-called leverage ratio restriction. They even propose to consider the introduction of a leverage ratio restriction at an international level.[2] The main reason behind these efforts are the rising concerns about the ability of supervisors to validate the banks' risk assessments, and hence the fundamental concerns whether Basel II can be implemented effectively.[3] Banks on the other hand strongly oppose such a leverage ratio restriction. They argue that it would reduce or even eliminate the benefits of the new, but complex and costly capital framework. Furthermore, they view a simple leverage ratio as an old-fashioned, blunt instrument, which is at odds with today's risk management of banks. Given the prominent role of a leverage ratio restriction in US banking regulation and the fierce debate about its future, it is surprising that there is no formal analysis about the pros and cons of such a regulatory arrangement. This paper is trying to start to fill this gap.

In an adverse selection model with profit-maximizing banks and costly capital, the effectiveness of risk-sensitive capital requirements à la Basel II is analyzed. Because the supervisor has only limited information about the banks' risk *ex ante*, i.e., before any uncertainty about banks' investments has been resolved, he has to rely on banks' reporting of their risk. But since banks know that reporting a high risk leads to a higher level of required capital, they have an incentive to understate their risk. In

[1] See Basel Committee on Banking Supervision (2006a).

[2] See Bair (2006).

[3] For instance, the so-called fourth quantitative impact study ('QIS4') in the United States has revealed a huge dispersion in banks' own calculations of required capital under Basel II. This dispersion is difficult to reconcile with supervisors' assessments of the analyzed banks' risks. See Curry (2005). The fifth quantitative impact study ('QIS5') has produced similar results (Basel Committee on Banking Supervision 2006b). For a general discussion of the potential problems associated with Basel II, see Bichsel and Blum (2005).

order to induce truthful revelation of banks' risks, it is necessary that the supervisor sanctions dishonest banks whenever such banks are detected *ex post*, i.e., after the return on banks' investments has been realized. If the supervisor's ability to detect or to sanction dishonest banks is limited, however, risky banks still have an incentive to understate their risk. In that case, an additional leverage ratio restriction helps to align risky banks' incentives and induces truthful revelation of their risk by reducing the risky banks' gains of understating their risk: First, the leverage ratio puts a ceiling on the put option value of limited liability. As banks have more of their own money invested, they bear a larger part of the downside risks themselves. Second, the possibilities of the supervisor to sanction dishonest banks are enlarged. Given limited liability, the size of the fine that can be imposed on banks is restricted by the level of the banks' capital. Hence, setting a capital floor ensures a minimum size of potential fines on banks. Both effects reduce the expected profits of banks that understate their risk. By imposing a sufficiently high leverage ratio, it becomes in the risky banks' own interest to report their risk truthfully. The better the supervisor's ability to detect and to punish untruthful banks, the lower is the necessary leverage ratio. If the supervisor's ability is very high, a leverage ratio may even become superfluous. At the other extreme, if the supervisor has no ability to detect or to punish banks, the second-best capital regulation reduces to a simple leverage ratio without any additional risk-sensitive requirements.

The downside of an additional leverage ratio is that it imposes a binding restriction on safe banks. The leverage ratio forces safe banks to hold too much capital, i.e., more capital than would be necessary for them to avoid insolvency. These regulatory costs have to be taken into account when assessing the overall desirability of capital regulation. It is shown that if the costs of bank failure and the fraction of risky banks are high and the cost of capital is relatively low, introducing capital requirements increases social welfare.

To our knowledge, the complementary use of risk-sensitive capital requirements and of leverage ratio restrictions has not yet been formally analyzed. Most closely related to this paper, Rochet (1992) argues that risk-averse banks may exhibit risk-loving behavior, if capital is very low or even negative. The reason for this result is the fact

that at very low levels of capital, the convexity of the profit function induced by limited liability dominates the concavity of the banks' utility function. To keep banks away from this region of excessive risk taking, Rochet suggests a capital floor in addition to risk-sensitive requirements. In contrast to the present paper, however, there are no asymmetries of information between the supervisors and the banks. In particular, the systematic risk of all the banks' assets are known to everybody. Moreover, the mentioned capital floor is an absolute value, i.e., independent of the banks' size,[4] while in this paper the relevant capital restriction is proportional to the total value of banks' assets.

Despite the lack of theoretical work on this topic, there is some empirical evidence that having a combination of risk-sensitive requirements and of a leverage ratio is superior to having either one by itself (e.g., Avery and Berger 1991, or Estrella, Park, and Peristiani 2000). Furthermore, it has been suggested informally that a leverage ratio may serve as a safeguard against potential shortcomings of risk-sensitive requirements, notably regulatory arbitrage and problems of validation (e.g., Bichsel and Blum 2005).

The rest of the paper is organized as follows. The next section describes the model. In Section 3, the capital choice of unregulated banks is compared with various regulatory arrangements: A simple leverage ratio, risk-weighted capital requirements, risk-weighted requirements with sanctions, and the combination of a leverage ratio and risk-weighted requirements. The subsequent section analyzes the welfare effects of capital regulation. Section 5 discusses the policy implications of the analysis. The final section contains a summary.

2 The Model

The model described in this section aims to capture three essential features of banking that are relevant for the analysis of capital regulation, especially risk-sensitive capital regulation à la Basel II. First, there is heterogeneity among banks' risks. Some banks

[4]Minimum capital levels that are independent of banks' size and risk are often part of banking regulation. In Switzerland, for instance, banks need at least 10 mio. Swiss Francs of capital in order to obtain a banking licence.

are riskier than others. Second, banks are highly opaque. As a consequence, outsiders, including relatively well-informed supervisors, have great difficulties in assessing banks precisely. In particular, while it may seem clear in some cases *ex post* that some banks have incurred high risks, it is very difficult to assess banks' risks *ex ante*. And third, from a welfare point of view, banks have a tendency to hold too little capital relative to their risks. Due to limited liability and negative externalities, banks do not fully take into account all the costs that arise to third parties in the event that the banks default.

There are two types of banks, safe banks and risky banks. The types are known to the banks themselves, but due to banks' opaqueness the types are not observable or verifiable by outsiders *ex ante*, i.e., before any uncertainty about the banks' investments is resolved.[5] Moreover, all banks are independent, which implies that information about one bank does not reveal information about any other banks.

Both types have total assets normalized to one and both are financed with deposits D and capital W. For convenience, we assume that there is full deposit insurance. As a consequence, deposits are riskless and the gross interest rate on deposits is equal to the riskfree rate, which is set to one.[6] Since banks' risk cannot be observed, the insurance premium is constant and by assumption set to zero. Capital is assumed to be more expensive than deposits. Specifically, the opportunity cost of capital, c_w, is larger than the interest rate on deposits, i.e., $c_w > 1$.

A bank supervisor may learn the true type of a bank with probability q *ex post*, i.e., after the return of the bank's investment has been realized. This corresponds to the backtesting mechanism that is used for the internal-models approach for market risks under Basel I.[7] It seems very likely that this will also be the mechanism used under Basel II, as it is very difficult to assess precisely banks' risks *ex ante*. The simplifying assumption that supervisors have no information at all *ex ante* is, of course, extreme. But the qualitative results of this paper would not be changed in a more realistic setting

[5] On the opaqueness of banks, see Morgan (2002).

[6] By assuming deposit insurance, we abstract from issues of market discipline. For an overview of market discipline, see Flannery (2001).

[7] See Basel Committee on Banking Supervision (1996).

where supervisors do have some information *ex ante*. It is important, however, that irrespective of the initial information supervisors do know more *ex post*. This ensures that supervisors are in a better position to discipline misbehaving banks *ex post* than *ex ante*. Note that the validation of risk models is not an issue here: Both banks have perfect internal models in the sense that they know exactly what risk type they are. The difficulty for the supervisor consists in verifying the information input that goes into these models, as most of this information is soft, non-market, and low-frequency data. This point will be discussed in more detail in Section 5.

The safe banks have a gross rate of return on assets $1+x$. The risky banks' return $\tilde{R}$ has the following distribution:

$$\tilde{R} = \begin{cases} 1+x & \text{with probability} \quad p \\ 1-x & \text{with probability} \quad 1-p \end{cases},$$

with $p > \frac{1}{2}$. Given this assumption, while less profitable than the safe banks, risky banks are still socially desirable in the sense that their expected return, $1+2px-x$, is larger than the riskfree rate. In addition, we assume that the expected return is higher than the opportunity cost of capital, c_w. This implies that risky banks are profitable at any level of capital. Note that the risky banks cannot be distinguished from the safe banks in case of success of their investment. In that case, both types of banks have the same rate of return $1+x$.

The failure of a bank leads to social costs C. These costs include externalities in the form of contagion effects and disruptions of the payments system. Furthermore, contractions in the amount of available credit due to a banking crisis have a negative impact on economic growth and lead to costs in the form of reduced real output.[8] An insolvent bank does not incur any private bankruptcy costs. Furthermore, due to limited liability the bank owners cannot be forced to cover any losses.

[8] On the costs of banking problems, see Hoggarth and Saporta (2001) or Boyd, Kwak, and Smith (2005).

3 The Incentives of an Individual Bank

As a reference point, we first describe the first-best capital allocation for the two types of banks. If there were no asymmetries of information, safe banks would have to hold no capital at all. By minimizing capital, the financing costs are minimized and hence the total surplus is maximized. Since these banks are riskless, no capital buffer is needed to prevent any insolvencies.

In contrast, it may be efficient for risky banks to hold a positive amount of capital. Specifically, if the social costs of insolvency are high, it is efficient for risky banks to hold just enough capital in order to avoid insolvency. To see this, note that risky banks without any capital cause expected insolvency costs of $(1-p)C$. In order to prevent bankruptcy, they have to hold an amount of capital x, which has an opportunity cost of $c_w x$. Therefore, if $(1-p)C > (c_w - 1)x$, it is socially optimal for risky banks to hold enough capital to avoid bankruptcy. In the rest of the paper we assume that this condition is met, i.e., that the costs of insolvency are sufficiently high:

$$C > \frac{(c_w - 1)x}{1-p}. \tag{1}$$

Under Assumption (1), the first-best amount of capital for risky banks is x.

3.1 No Regulation

To demonstrate the potential benefit of capital regulation, we now examine the banks' financing decision in the absence of any restrictions. The safe banks' (non-random) profits π^s are given by

$$\pi^s = (1+x)(D+W) - D - c_w W.$$

Using the balance sheet identity, $D + W \equiv 1$, this can be rewritten as

$$\pi^s = x - (c_w - 1)W. \tag{2}$$

Since $c_w > 1$, these profits are maximized, if capital W is minimized, i.e., if $W = 0$.[9] Therefore, a safe bank will voluntarily hold the first-best amount of capital. Its profits

[9] The first derivative of (2) with respect to W is $1 - c_w$, which is always negative.

are $\pi^s = x$.

Due to the possibility of insolvency, the risky banks' expected profit function π^r is slightly more complicated:

$$\pi^r = p[(1+x)(D+W) - D] + (1-p)\max\{(1-x)(D+W) - D, 0\} - c_w W. \quad (3)$$

With probability p, a high return is realized and the payoff is the same as for the safe banks. With probability $(1-p)$, a low return is realized. In that case, limited liability protects the banks from incurring a loss. This is represented by the $\max\{.\}$ expression in the second term of (3), which ensures a minimum payoff of zero to the risky banks. The risky banks' expected profits are also maximized, if the amount of capital W is set to zero[10], i.e.,

$$\pi^r = px. \quad (4)$$

Therefore, an unregulated risky bank will hold too little capital relative to first best. While the cost of capital has to be borne by the banks, the banks themselves do not benefit from the reduced insolvency costs. It is due to this externality that the risky banks' privately optimal capital choice is not socially optimal.

To sum up, without any regulation both types of banks will finance their assets with deposits exclusively. Because capital is more costly than deposits and because there is no private benefit to holding capital, banks do not hold any capital at all.

3.2 Simple Leverage Ratio Restriction

The simplest and historically oldest form of capital regulation is a lower bound to the ratio of capital to total assets – a leverage ratio restriction. In the context of this model with normalized assets of size one, a leverage ratio restriction is equivalent to requiring a minimum amount of capital $W_{\min}$.

By setting $W_{\min} = x$, the risky banks' capital buffer is big enough to prevent any insolvencies. While such a crude leverage ratio restriction solves the externality problem of risky banks, it has the downside that it imposes an undue cost on safe

[10] The first derivative of (3) with respect to W is always negative, both when $W \geq x$ and when $W < x$.

banks. Since the supervisor is not able to identify the banks' types *ex ante*, the safe banks also have to hold a positive amount of capital – even though they would be safe enough without any capital. In effect, the distortion of excessive risk taking is removed at the expense of introducing another distortion in the form of raising the financing costs of safe banks above their first-best level.

An important motivation for Basel II is to solve this dilemma. The goal is to make required capital dependent on each bank's level of risk. To achieve such risk sensitivity, the main innovation vis-à-vis Basel I is the so-called Internal Ratings Based Approach. Under this approach, the banks determine the risk of their assets themselves and report this risk to the supervisor. The supervisor in turn sets the required capital on the basis of this report. The following section formalizes this approach.

3.3 Basel II: The IRB Approach

Under the Internal Ratings Based Approach (IRB Approach), a bank determines important risk parameters of its credit portfolio based on its own internal calculations. The bank then reports these parameters to the supervisor, who in turn sets the bank's required capital based on these reports.[11] In this paper, we model this approach as follows. In the first step, a bank announces its type. In the second step, the supervisor sets the bank's minimum capital conditional on the announced type.

In order to implement the first-best allocation, the supervisor requires the risky banks to hold capital $W_{\min}(risky) = x$ and the safe banks to hold no capital, $W_{\min}(safe) = 0$. The safe banks' decision is trivial, as they never have an incentive to pretend to be of the risky type. They always correctly report their type. The risky banks in contrast may choose whether to announce their type correctly or not. If risky banks claim to be safe, they do not have to hold any capital and their payoff is the same as in the absence of any regulation, $\pi^r(safe) = px$ (see Equation 4). If they truthfully announce

[11] See Basel Committee on Banking Supervision (2006a) for details on this approach and on Basel II in general.

to be risky, due to the capital requirement $W = x$ their payoff is

$$\begin{aligned}\pi^r(risky) &= p[(1+x)(D+W) - D] + (1-p)\max\{(1-x)(D+W) - D, 0\} - c_w W \\ &= (2p - c_w)x. \end{aligned} \tag{5}$$

Recalling that $p < 1 < c_w$, it becomes directly evident that the expected payoff of being honest is smaller than the payoff of being dishonest.[12] This leads to the following sobering result.

Result 1 *Risk-sensitive capital requirements that rely on banks' voluntary disclosure of their risk profiles do not work.*

Anticipating the supervisor's behavior, the risky banks have a strong incentive to lie about their true type. By announcing their type as 'safe' they don't have to hold any capital, which corresponds to their preferred capital structure in the absence of any regulation. As a result, all banks announce that they are of the safe type, *independent* of their actual type. In other words, capital adequacy rules that simply rely on the banks' own announcements of their risk do not work. This, of course, is not really surprising. Banking regulation only makes sense in the first place, if banks do not always behave in a socially efficient manner on a voluntary basis. If they always did act in a welfare maximizing way, there wouldn't be any need to regulate banks. Relying on the banks' own announcement of their risk, however, is equivalent to letting them directly choose their required capital themselves. Since unregulated risky banks have a tendency to hold too little capital, a mechanism that is based on the *voluntary* disclosure of banks' types will not correct this tendency.

Risky banks are not truthful about their type because they would incur a 'penalty' in the form of higher financing costs, if they were honest. In contrast, lying about their type does not affect their payoff. A possible solution to this problem consists in imposing sanctions on banks and, hence, reducing the dishonest banks' expected payoffs, whenever the supervisor finds out that a bank was lying *ex post*. This enhanced mechanism is analyzed in the next section.

[12] Since we assumed that the risky banks' expected return is higher than the cost of capital c_w, the expected return of honest risky banks is positive, i.e., $2p - c_w > 0$.

3.4 Basel II: The IRB Approach Plus Sanctions

As in the previous section, banks first announce their type and, second, the supervisor imposes capital requirements based on these announcements. In a new, third step the supervisor examines banks after the returns have been realized. If a bank is not insolvent, the supervisor learns with probability q whether a bank has been dishonest.[13] Fourth, if a bank is detected as having misstated its type, the supervisor imposes a penalty F on the bank. This penalty consists of confiscating a fraction s of the bank's capital after profits, W_1, i.e., $F = sW_1$.

For at least two reasons, the ability of the supervisor to impose sanctions is limited, i.e., we would typically expect $s < 1$. First, the result of the supervisory exam is difficult to verify for outsiders. As a consequence, the supervisor may have a hard time enforcing any penalties, as it is difficult to prove the bank's wrongdoing. By the same token, the limited verifiability facilitates regulatory forbearance, since any laxity on the part of the supervisor is not easily detected. Second, there may be considerable political pressure on the supervisor not to be too tough with banks. After all, *ex post* no damage has been done. So why punish a solvent bank, which to the general public is not distinguishable from an efficient safe bank? This reluctance to punish dishonest banks is augmented, if the intended penalty threatens the bank's solvency or even implies the closing down of an otherwise healthy bank.

The case of safe banks again is trivial, because they always honestly announce their true type and are never detected as liars. Hence, their payoff is not affected by this enhanced IRB Approach. The risky banks' decision, however, is affected as the potential sanctions influence their profits. If a risky bank is honest, it has to hold capital $W_{\min}(risky) = x$. In return, the bank is never sanctioned. Therefore, the honest risky bank's expected payoff $\pi^r(risky)$ is the same as before (see Equation 5),

$$\pi^r(risky) = (2p - c_w)x. \tag{6}$$

If the risky bank is dishonest, it is not required to hold any capital ($W = 0$ and

[13] If the bank is insolvent, it has been dishonest with certainty. Due to limited liability, however, the supervisor cannot impose any sanctions in that case.

$D = 1$). However, with probability q it will incur a penalty F. Therefore, the dishonest risky banks' expected payoff $\pi^r(safe)$ is now

$$\pi^r(safe) = p\,[(1+x)D - D - qF]$$

Using $F = sW_1 = s[(1+x)D - D] = sx$ yields

$$\pi^r(safe) = p\,(1 - qs)\,x. \tag{7}$$

Comparing (6) and (7), the risky bank's expected payoff of being honest is higher than the expected payoff of being dishonest, if and only if

$$qs > \frac{c_w - p}{p}. \tag{8}$$

As the right-hand side of condition (8) is always positive, risky banks can only be induced to be truthful, if the supervisor's ability both to detect (q) and to punish (s) dishonest banks is sufficiently high. Note that both of these abilities, detection *and* punishment, are necessary to induce truth telling by risky banks. For instance, if the supervisor has perfect knowledge of banks' types ($q = 1$), but no powers to enforce any sanctions ($s = 0$), all risky banks still lie about their type. The same is true for a tough ($s = 1$), but completely uninformed ($q = 0$) supervisor. This is summarized in the following result.

Result 2 *If the supervisor detects dishonest banks only with low probability or if the supervisor is weak (i.e., cannot enforce high penalties), risky banks understate their risk.*

If condition (8) is violated, the IRB Approach does not work as intended. Risky banks fare better if they lie about their type than if they disclose their type correctly. This observation directly suggests a potential remedy for the problem: If one manages to raise the relative profitability of being honest, the incentive compatibility condition (8) may be relaxed in such a way as to render the truthful revelation of types the dominant strategy for all banks. The next section demonstrates that this can indeed be achieved by imposing an additional leverage ratio restriction on banks.

3.5 Basel II: The IRB Approach Plus Leverage Ratio Restriction

We extend the model by introducing a simple leverage ratio restriction. Independent of the announced type, all banks have to hold some minimum amount of capital $\hat{W}_{\min} \leq x$. Whether this additional constraint is actually binding or not depends on the type announced by each bank. If banks claim to be high-risk banks, the risk-weighted capital rule requires them to hold enough capital to avoid insolvency, i.e., $W_{\min} = x$. These banks have to hold at least as much capital as the leverage ratio restriction requires anyway. Hence, for them the leverage ratio restriction is not binding. It is binding, however, for banks that announce the type 'safe'. Based on the risk-weighted rules alone, they don't have to hold any capital. Therefore, for these banks the leverage ratio restriction represents the binding constraint.

Because the leverage ratio restriction is not binding for an honest risky bank, the expected payoff in this modified framework is the same as before (see Equation 6). The expected payoff of a dishonest risky bank (Equation 7), however, is altered due to the binding leverage ratio restriction:[14]

$$\begin{aligned} \hat{\pi}^r(safe) &= p\left[1 + x - (1 - \hat{W}_{\min})\right](1 - qs) - c_w \hat{W}_{\min} \\ &= p\,(1 - qs)\,(x + \hat{W}_{\min}) - c_w \hat{W}_{\min}. \end{aligned} \tag{9}$$

A comparison of (7) and (9) shows that a dishonest risky bank's expected payoff is lower in the presence of a leverage ratio restriction, $\hat{\pi}^r(safe) < \pi^r(safe)$. Furthermore, the expected payoff $\hat{\pi}^r(safe)$ is decreasing in the leverage ratio requirement $\hat{W}_{\min}$.

Since the honest banks' payoff is not affected, changes in the leverage ratio restriction directly affect the relative profitability of being honest and of being dishonest. The leverage ratio restriction $\hat{W}_{\min}(qs)$ that makes risky banks indifferent between lying and telling the truth can be determined by equating (6) and (9). Doing so yields the minimal, truth-inducing leverage ratio requirement

[14] Recall the balance sheet identity $D + W \equiv 1$. Therefore, $D = 1 - \hat{W}_{\min}$.

$$\hat{W}_{\min}(qs) = \frac{p(1-qs) - (2p - c_w)}{c_w - p(1-qs)} x. \tag{10}$$

This means that given the supervisor's abilities qs, the leverage ratio restriction $\hat{W}_{\min}(qs)$ defined by (10) in combination with the risk-sensitive capital requirement ensures that risky banks report their risks honestly:

Result 3 *If the supervisor imposes a leverage ratio restriction $\hat{W}_{\min}(qs)$ in addition to the risk-sensitive capital requirement, all banks announce their type truthfully.*

To better understand the mechanism that leads to this result, it is useful to rewrite the dishonest risky banks' payoff (9) as

$$\hat{\pi}^r(safe) = \left\{ p \left[1 + x - (1 - \hat{W}_{\min}) \right] - c_w \hat{W}_{\min} \right\} - pqF, \tag{11}$$

where the sanction $F = s[x + \hat{W}_{\min}]$. Introducing or raising the capital ratio $\hat{W}_{\min}$ has two effects: First, as can be seen from the expression in curly brackets in Equation (11), the banks' expected payoff excluding any potential sanctions is reduced. The higher the amount of capital that the banks have to hold, the more of the downside risk they have to bear themselves. In other words, the put option value of limited liability[15] is reduced. Second, the expected sanction increases as the leverage ratio is raised. This corresponds to the second term in Equation (11). As the bank owners have to invest more of their own funds, there is a higher net worth of banks that the supervisor may confiscate. Both of these effects reduce the risky banks' expected payoff of understating their risks. Hence, by choosing a sufficiently high level of the leverage ratio, the supervisor can reduce the payoff of understating risks by enough to ensure that risky banks voluntarily choose to announce their risk type truthfully.

Furthermore, Equation (10) reveals some interesting comparative statics. The lower the supervisor's ability to detect banks' true types (q) or the lower the supervisor's

[15] In this model, the put option value of limited liability corresponds to the expected loss, which does not have to be borne by the bank owners, $(1-p)(x-W)$. This is the absolute value of the limited-liability term in equation (3).

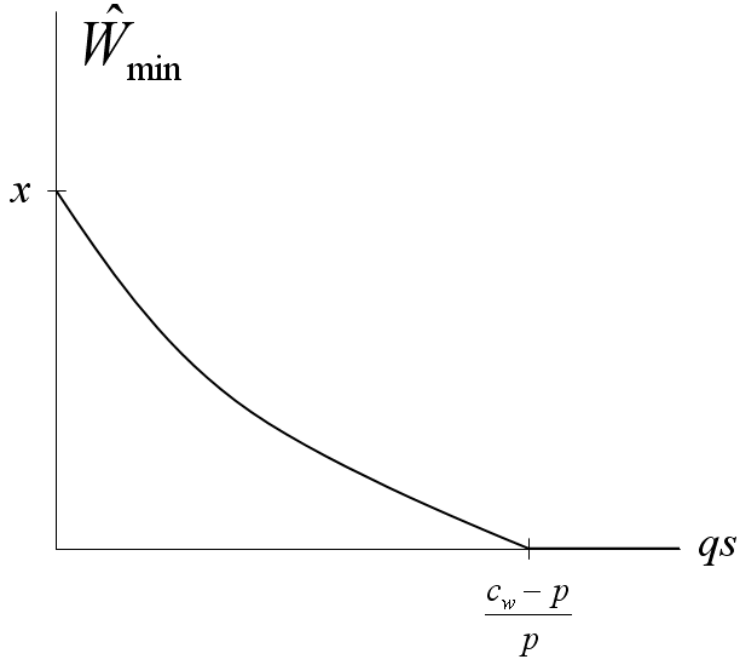

Figure 1: Relationship between the supervisor's ability and the leverage ratio restriction

ability to enforce sanctions (s), the higher is the necessary leverage ratio restriction to ensure truth telling (i.e., $\partial \hat{W}_{\min}/\partial qs < 0$). In this sense, a simple leverage ratio restriction is a substitute for supervisory knowledge and power. If the supervisor can never detect banks' true types ($q = 0$) or if the supervisor cannot enforce any sanctions ($s = 0$), the capital regulation reduces to the simple leverage ratio restriction discussed in Section 3.2. In this case, the risk-sensitive capital requirement is irrelevant. At the other extreme, if the supervisor's abilities (qs) are high enough, an additional leverage ratio restriction may not be needed: If condition (8) is fulfilled, $\hat{W}_{\min}(qs) = 0$.[16] For intermediate values of qs, some leverage ratio restriction $\hat{W}_{\min}(qs) > 0$ in addition to the risk-sensitive capital requirement is necessary to ensure truthful revelation of banks' risk types. The relationship between the supervisor's abilities qs and the minimum leverage ratio restriction $\hat{W}_{\min}(qs)$ is summarized in Figure 1.

[16] If $(c_w - p)/p > 1$, i.e., if the cost of capital is very high and the probability of success is low, even a perfect supervisor ($qs = 1$) is not sufficient to induce risky banks to be honest. In that case a leverage ratio restriction is indispensable.

4 Welfare Analysis

Due to the externality of bank failures, it is efficient to impose capital requirements on risky banks in order to avoid these failures. More precisely, it was assumed that the expected social bankruptcy costs are higher than the opportunity costs of the insolvency-avoiding amount of capital (Assumption 1). The welfare implications of such a regulation for a whole banking sector, however, are not obvious. As was demonstrated in the previous section, safe banks also bear the costs of the regulation, without any corresponding benefit. Depending on the magnitude of the insolvency costs and the fractions of safe and risky banks, the increased aggregate financing costs for safe banks may outweigh the total benefit of avoiding insolvencies at risky banks. This section derives the condition under which imposing a capital requirement on a whole banking sector is indeed socially efficient.

The combination of risk-sensitive capital requirements and a leverage ratio restriction always (weakly) dominates a simple leverage ratio restriction. As shown in the previous section, both regulations prevent insolvencies of risky banks. But under the combined regulation the required amounts of capital for safe banks, and accordingly the regulatory costs, are lower than under the risk-insensitive restriction.[17] Therefore, we only have to compare social welfare of an unregulated banking sector with social welfare of the banking sector under the optimal combined capital regulation. Recall that in the absence of any regulation, all banks choose to hold no capital at all. If there is a fraction θ of risky banks and a fraction $1-\theta$ of safe banks, average expected social surplus without any regulation in place is

$$\begin{aligned} S_{unreg} &= \theta[p(1+x-1)+(1-p)(1-x-1-C)]+(1-\theta)[1+x-1] \\ &= \theta[(2p-1)x-(1-p)C]+(1-\theta)x. \end{aligned} \tag{12}$$

If all banks are subject to an incentive-compatible combination of risk-weighted capital

[17] Formally, this is reflected in the fact that $\hat{W}_{\min} \leq x$.

requirements and a leverage ratio restriction, average expected surplus is

$$\begin{aligned} S_{reg} &= \theta[p(1+x-(1-x)) - c_w x] + (1-\theta)[1+x-(1-\hat{W}_{\min}) - c_w \hat{W}_{\min})] \\ &= \theta[(2p-c_w)x] + (1-\theta)[x-(c_w-1)\hat{W}_{\min}]. \end{aligned} \tag{13}$$

Comparing (12) and (13), it follows that capital regulation increases social welfare if

$$\theta(1-p)C > (c_w-1)[\theta x + (1-\theta)\hat{W}_{\min}]. \tag{14}$$

The left-hand side of (14) represents the benefit of capital regulation, i.e., the reduction of average expected bankruptcy costs. The right-hand side represents the costs of regulation, i.e., the increase of average funding costs due to the higher costs of capital relative to deposits.

The interpretation of condition (14) is intuitive and straightforward. First, it is more likely that capital regulation increases social welfare, if expected bankruptcy costs are high. Since the capital requirements prevent bank insolvencies, the benefit of the requirements is increasing in the value of the avoided bankruptcy costs. Second, the net effect of capital regulation on social welfare is higher, the larger the share of risky banks. If there are many risky banks, the benefit of reducing bankruptcy costs applies to many banks (left-hand side of 14). Furthermore, the 'collateral damage' of capital regulation, i.e., the higher financing costs for safe banks, is imposed on relatively few banks (the last term on the right-hand side of 14). And third, social welfare of regulation is higher, the lower the cost of capital. The regulated banks hold more capital than they voluntarily would. The costs of these required capital holdings, and hence the costs of capital regulation, are decreasing in the cost of capital. These findings are summarized in the following result.

Result 4 *If the bankruptcy costs of bank failure C and the fraction of risky banks θ are sufficiently high and if the cost of capital c_w is sufficiently low, i.e., if condition (14) is satisfied, introducing an incentive-compatible combination of risk-weighted capital requirements and a leverage ratio restriction increases social welfare.*

5 Policy Implications

A simple leverage ratio restriction is a rather blunt tool that does not take into account any differences between banks. In particular, it ignores any potential differences in risk profiles. Independent of the level of risk, all banks have to meet the same minimum capital ratio. As a consequence, some banks may be too safe, i.e., they have to hold more capital than would be socially optimal, while other banks may hold too little capital relative to the risks they incur. Risk-sensitive capital requirements for banks intend to reduce this regulatory distortion. Since banks by the nature of their business are highly opaque, however, the assessment of their risk by outsiders presents a major problem. Under Basel II, this problem is solved by delegating the risk assessment to the banks themselves. As this analysis demonstrates, however, this solution may be illusory.

Delegating the risk assessment to the banks, under Basel II using the Internal Ratings Based Approach, assumes that somehow the banks will have an incentive to truthfully reveal their risk. But this assumption violates the main reason why banks need to be regulated in the first place: They may not always have the incentive to behave in a socially efficient manner. Accordingly, if banks have a tendency to hold too little capital, why should banks be honest when reporting their risk to the supervisor, knowing precisely how this reporting translates into a minimum level of required capital? This paper shows that simply relying on banks' own announcement of their risk does not lead to adequate capital levels at risky banks. Risky banks have a strong incentive to hide the fact that they are risky in order to economize on costly capital.

To make a system of banks' reporting their own risk work, a mechanism to detect and to sanction untruthful banks is a necessary condition. Only the threat of being exposed and punished may induce risky banks to be honest about their risk assessment. Interestingly, the whole Basel II framework is completely silent about this question. It seems clear that an international coordination of regulatory sanctions is a politically difficult matter. Nevertheless, it is essential for Basel II to work and to create a

so-called level playing field. If supervisors either lack the ability to detect dishonest banks or are unable to enforce drastic sanctions, the new elaborate capital rules may be ineffective and in that sense may be inferior to a simple, risk-independent leverage ratio restriction.

The main message of this paper is that even if supervisors do have some ability to detect and sanction dishonest banks, an additional leverage ratio may be needed to enhance this ability. First, a minimum level of capital restricts the banks' put option value of limited liability. Imposing a minimum capital ratio ensures that at least some fraction of the negative consequences of incurring higher risks are borne by the bank owners themselves.[18] Second, a higher level of capital expands the possibility of supervisors to sanction banks. If the banks' net worth is higher, the supervisors are able to make banks pay higher penalty fees without jeopardizing the banks' solvency. This in turn makes the threat of sanctions more powerful *ex ante*. Together, these two effects reduce the banks' incentives to be dishonest about their type, as the difference in expected payoffs between lying and telling the truth is reduced or even eliminated.

Unfortunately, the benefit of setting the incentives of risky banks correctly does not come without any costs. Since the risk-independent leverage ratio restriction has to be fulfilled by all banks, the costs of this additional measure have to be borne by the safe banks. They have to hold more capital than would be socially efficient and they become 'too safe'. In terms of keeping required capital as low as possible while ensuring banks' holding an appropriate minimum amount of capital, however, the combination of risk-sensitive capital requirements and a leverage ratio restriction is superior to the alternative where all banks are subject to a simple leverage ratio. For the riskiest banks, the complementary use of risk-sensitive capital requirements and a leverage ratio does not distort their capital structure. These banks end up holding exactly the first-best level of capital.

It may seem surprising at first sight that capital requirements based on banks'

[18] Furthermore, but not modelled in this paper, this helps to reduce the most severe forms of excessive risk taking, which occur when banks have no or even negative capital. See Rochet (1992), for instance, for a rigorous presentation of this point, or Kane's (1989) account of the 'zombie banks' that were 'gambling for resurrection' during the Savings & Loans crisis in the 1980s in the United States.

own risk assessments may not be effective. After all, under Basel I banks' internal models are used to measure and to report their market risks of their trading books. The amount of required capital is a direct function of the reported risks. And as in this paper's model, the supervisors use backtesting procedures to detect banks that were understating their risks. All in all, this mechanism is working very well. So why might it not work when applied to whole banks? The big difference is precisely that under Basel I, the self-assessment of banks is limited to a fraction of their balance sheets. As a consequence, if an understatement of risks is detected, the supervisors are able to impose sanctions on the remaining, still solvent part of the banks. However, if the self-assessment is extended to the whole balance sheet, the supervisors may not be able to sanction banks because in many cases the banks will be insolvent when it will become obvious that they took higher risks than reported. Another important difference is that in the case of market risk in the trading books, there is daily data on exposures and returns, whose plausibility is readily verifiable as it is market data. As a result, the detection of dishonest banks is relatively easy. In other bank activities, in particular in the lending business, however, there is only very low-frequency data, whose quality is difficult to verify due to the banks' opaqueness. This renders the job of supervisors to detect dishonest banks extremely challenging.

6 Summary

In a model where unregulated banks hold too little capital relative to first best and where supervisors know the potential risk types of banks, but not the actual type of each bank, the combination of a risk-sensitive requirement and a simple leverage ratio restriction represents the second-best capital regulation. The risk-sensitive requirement, where banks assess their own risks and report these assessments to the supervisors, makes sure that the banks' private information is taken into account when determining required capital. Since reporting a high level of risk results in a high level of required capital, however, risky banks have an incentive to understate their risks. In order to induce truthful revelation of their risks, the supervisors need some ability

to detect and to punish dishonest banks. The threat of potential sanctions reduces banks' incentives to misrepresent their risks. To compensate for the limited ability of supervisors to detect dishonest banks and to enforce sanctions, the leverage ratio restriction may be necessary. Imposing a minimum capital ratio reduces the banks' benefit of understating their risks, as the potential savings in required capital are reduced, and it enhances the supervisors' threat of sanctions, as the higher net worth allows the supervisor to charge higher penalty fees.

References

[1] Avery, Robert and Allen Berger (1991): 'Risk-based Capital and Deposit Insurance Reform', *Journal of Banking and Finance* 15, 847-874.

[2] Bair, Sheila (2006): Statement on the Interagency Proposal Regarding the Basel Capital Accord, Senate Hearing, September 26.

[3] Basel Committee on Banking Supervision (1996): 'Amendment to the Capital Accord to Incorporate Market Risks', Bank for International Settlements, January.

[4] Basel Committee on Banking Supervision (2006a): 'International Convergence of Capital Measurement and Capital Standards: A Revised Framework – Comprehensive Version', Bank for International Settlements, June.

[5] Basel Committee on Banking Supervision (2006b): 'Results of the Fifth Quantitative Impact Study (QIS 5)', Bank for International Settlements, June.

[6] Bichsel, Robert and Jürg Blum (2005): 'Capital Regulation of Banks: Where Do We Stand and Where Are We Going?', Swiss National Bank, *Quarterly Bulletin*, December, 42-51.

[7] Boyd, John, Sungkyu Kwak, and Bruce Smith (2005): 'The Real Output Losses Associated with Modern Banking Crises', *Journal of Money, Credit, and Banking* 37(6), 977-999.

[8] Curry, Thomas (2005): Statement on Basel II: Capital Changes in the U.S. Banking System and the Results of the Impact Study, House of Representatives Hearing, May 11.

[9] Estrella, Arturo, Sangkyun Park, and Stavros Peristiani (2000): 'Capital Ratios as Predictors of Bank Failure', Federal Reserve Bank of New York Economic Policy Review, July, 33-51.

[10] Flannery, Mark (2001): 'The Faces of Market Discipline', *Journal of Financial Services Research* 20, 107-119.

[11] Hoggarth, Glenn and Victoria Saporta (2001): 'Costs of Banking System Instability: Some Empirical Evidence', Bank of England, *Financial Stability Review*, June.

[12] Kane, Edward (1989): 'The High Cost of Incompletely Funding the FSLIC Shortage of Explicit Capital', *Journal of Economic Perspectives*, Autumn 1989, 31-47.

[13] Morgan, Donald (2002): 'Rating Banks: Risk and Uncertainty in an Opaque Industry', *American Economic Review* 92, 874-888.

[14] Rochet, Jean-Charles (1992): 'Capital Requirements and the Behaviour of Commercial Banks', *European Economic Review* 36, 1137-78.